

REMARKS

Applicants respectfully request reconsideration of the application, as amended, in view of the following remarks.

The present invention as set forth in **amended Claim 21** relates to a method for producing a flexible polyurethane foam, comprising:

reacting a polyol in an open mold with a polyisocyanate compound in the presence of a catalyst, a blowing agent, a silicone foam stabilizer having a silicone content of from 10 to 50 mass% and **a crosslinking agent having a molecular weight from 4000 to 10000 and at least two functional groups**, to form said flexible polyurethane foam,

wherein the polyol has a hydroxyl value of at most 15 mgKOH/g and the polyisocyanate compound is a prepolymer-modified polymethylenepolyphenyl polyisocyanate which comprises reacted units of polyethylene glycol monomethyl ether and polymethylenepolyphenyl polyisocyanate, and

wherein the polyol has an unsaturation value of at most 0.05 meq/g.

Amended Claim 40 relates to a method for producing a flexible polyurethane foam, comprising:

reacting a polyol in an open mold with a polyisocyanate compound in the presence of a catalyst, a blowing agent, a silicone foam stabilizer having a silicone content of from 10 to 50 mass% and **a crosslinking agent having a molecular weight from 4000 to 10000 and at least two functional groups**, to form said flexible polyurethane foam,

wherein the polyol has a hydroxyl value of at most 15 mgKOH/g and the polyisocyanate compound is a prepolymer polymethylenepolyphenyl polyisocyanate modified with a hydroxyl group containing compound, which is different from the polyol,

wherein the polyol has an unsaturation value of at most 0.05 meq/g, and

wherein said prepolymer polymethylenepolyphenyl polyisocyanate comprises reacted units of polyethylene glycol monomethyl ether and polymethylenepolyphenyl polyisocyanate.

Takeyasu et al and EP-1,022,300 A1 and Kiamil et al fail to disclose or suggest a method for producing a flexible polyurethane foam, as claimed, in which **a crosslinking agent having a molecular weight from 4000 to 10000 and at least two functional groups** is used.

The present invention relates to a method for producing a flexible polyurethane foam by reacting a polyol having a very high molecular weight (having a hydroxyl value of at most 15 mgKOH/g (which means that the molecular weight exceeds 11200 when the number of functional groups is 3 or more)) with a specific polyisocyanate compound in an open mold in the presence of a specific crosslinking agent (having a molecular weight from 4000 to 10000 and at least two functional groups) and a specific foam stabilizer. By virtue of the use of the specific crosslinking agent, it is possible to produce a low density flexible polyurethane foam with excellent foam stability at the time of foaming. The use of the specific crosslinking agent also improves durability of the resulting foam (page 16, lines 20-22). From the fact that when such a crosslinking agent was used in Example 9, the dry heat compression set was 1.7%, which is almost 20% lower than 1.4% in Example 8 in which no crosslinking agent was used, it is evident that the method of the present invention can provide a durable flexible polyurethane foam.

Takeyasu et al. (US 4,093,380) recites only compounds having a molecular weight way below 4000 as crosslinking agents (column 4, line 52 to column line 26), and does not disclose or suggest at all the specific crosslinking agent having a molecular weight of from 4000 to 10000 of the present invention.

EP-1,022,300 does not disclose or suggest the specific crosslinking agent having a molecular weight of from 4000 to 10000, either.

Production of slab foams using a high molecular weight polyol used to be impossible because of the poor foam stability at the time of foaming in an open mold.

However, the choice of the specific crosslinking agent has made it possible to produce flexible slab foams with good foam stability. The use of the specific polyisocyanate further has improved the resulting foam in durability.

By virtue of the use of the specific foam stabilizer, the specific polyisocyanate compound and the specific crosslinking agent, the method of the present invention can provide a durable flexible polyurethane foam.

Kiamil et al do not cure the defects of Takeyasu et al and EP-1,022,300 A1.

Thus, the present invention can be clearly distinguished from the cited references.

Moreover, Takeyasu et al and EP-1,022,300 A1 and Kiamil et al fail to disclose or suggest the claimed combination of a reaction in an open mold of a polyol having a hydroxyl value of at most 15 mg/KOH and an unsaturation value of at most 0.05 meq/g, and a prepolymer-modified polymethylenepolyphenyl polyisocyanate which comprises reacted units of polyethylene glycol monomethyl ether and polymethylenepolyphenyl polyisocyanate as claimed in Claim 21 or a prepolymer polymethylenepolyphenyl polyisocyanate modified with a hydroxyl group containing compound, which is different from the polyol, wherein said prepolymer polymethylenepolyphenyl polyisocyanate comprises reacted units of polyethylene glycol monomethyl ether and polymethylenepolyphenyl polyisocyanate as claimed in Claim 40.

Further, by using the specific polyisocyanate as defined in Claims 21 and 40, the dry heat compression set of the flexible polyurethane foam becomes small. This can be seen in

Table 3, Examples 8 and 9 (see last row of the Table). The dry heat compression set is 1.7 and 1.4 in Examples 8 and 9, respectively. Such superior results are not disclosed or suggested in Takeyasu et al and EP-1,022,300 A1 and Kiamil et al, alone or in combination.

In addition, Takeyasu et al and EP-1,022,300 A1 and Kiamil et al fail to disclose or suggest the claimed combination of a silicone foam stabilizer having a silicone content of from 10 to 50 mass% and a crosslinking agent. The only mold described in Takeyasu et al is a closed mold, as shown in the examples. See, for example, column 8, line 15.

EP-1,022,300 A1 (Sugiyama et al) discloses, *inter alia*, a polyurethane foam produced by using a particular polyether polyol having a hydroxyl number of from 5 to 38 mgKOH/g and a polyisocyanate such as diphenylmethane diisocyanate (MDI), polymethylene polyphenyl isocyanate (popular name: crude MDI), or its prepolymer type modified product [0077]. Sugiyama et al further discloses that molding is carried out preferably by a method of directly injecting a reactive mixture into a **closed mold** by using a low-pressure foaming machine or high-pressure foaming machine, or by a method of spreading a reactive mixture into a mold in an open state [0083]. All of the polyols exemplified by Sugiyama et al have a hydroxyl number higher than the presently-recited maximum of 15 mgKOH/g, as shown in Table 2 at page 15 thereof. None of the exemplified polyisocyanates is a **prepolymer-modified polymethylenepolyphenyl polyisocyanate** or a **prepolymer polymethylenepolyphenyl polyisocyanate modified with a hydroxyl group containing compound**, as claimed in Claims 21 and 40. See Table 3 bridging pages 15 and 16 thereof. In addition, in all the examples showing the production of a flexible polyurethane foam, a closed mold was used [0140]. Thus, Sugiyama et al does not anticipate the presently-claimed invention.

The present invention provides a method for producing a flexible polyurethane foam in which a polyol having a very high molecular weight (for example, if the hydroxyl value is

at most 15 mgKOH/g and the number of functional groups is 3, the molecular weight exceeds 11,200) is used and foaming is conducted in an open system. In the field of slabstock foam conventionally produced by foaming in an open system, it has been difficult to use such a high molecular weight polyol because stable foaming cannot be accomplished.

A factor by which the stable foaming can be made possible is selection of **a specific foam stabilizer**. Further, in order to significantly improve the durability of the obtained foam, a **specific polyisocyanate compound** is chosen. In order to accomplish a further stable foaming, **a specific crosslinking agent** is used.

The above **specific foam stabilizer** is one conventionally employed mainly for production of a rigid polyurethane foam. The foam stabilizer is **a silicone foam stabilizer having a silicone content of from 10 to 50 mass%. Thus, it has been surprising that flexible foam s can be obtained.**

The principle foam stabilizer used in the examples is foam stabilizer c2 (tradename: L-5421) (see Table 1 at page 22 of the specification). **It becomes possible to produce the slabstock foam stably by combining the foam stabilizer conventionally employed only for a rigid foam and a polyol for a flexible foam.** Here, foam stabilizer c1 (tradename: L-580) is one conventionally employed for production of slabstock foam. However, by using this foam stabilizer, slabstock foams having a high density can only be produced. Namely, if it is attempted to produce only a relatively low density slabstock foam having a density of, for example, at most 50 kg/m³, L-5421 is effective. Foam stabilizer c3 (tradename: L-5309) is used for production of usual flexible molded foam, and used as an auxiliary aid in the present application.

The **specific crosslinking agent** is an effective factor for conducting more stable foaming and production. Specifically, a crosslinking agent having a higher molecular weight as compared with conventional ones is used. In a certain view, it can be said to be a principle

polyol which has been generally used for production of flexible foams. Namely, as described in the present specification, it is particularly effective for stable foaming to use a polyol having a molecular weight of at least 4,000. Namely, since the principle polyol has a very high molecular weight, it is preferred to select a crosslinking agent having a high molecular weight in proportion therewith.

The reason is assumed as follows: Crosslinking agents generally have a large number of functional groups, for example, 6. Accordingly, it is considered that if the principle polyol has a high molecular weight and the crosslinking agent has a low molecular weight, there is a strong possibility that not all the functional groups of the crosslinking agent (for example, a hydroxyl group) can effectively be used. This consideration will easily be understood by assuming that if the crosslinking agent has a low molecular weight, the molecular size is small, and for example, when 5 of 6 hydroxyl groups play a role in reaction, another one hydroxyl group will have a relatively large steric hindrance and the reaction probability will be lowered.

From the comparison between Examples 8 and 9, no substantial difference is seen. This is considered attributable to the fact that the density is high to a certain extent at a level of about 48 kg/m^3 . It is also considered that if this is made to be lower than, for example, about 40 kg/m^3 , it is indispensable to use a crosslinking agent for stable production.

By employing the above-mentioned technical factors, the present invention has been accomplished. Namely, it becomes possible to produce a slabstock form by using the high molecular weight polyol. Takeyasu does NOT have a description directly suggesting the production of this slabstock foam. Particularly, none of these references describes the selective use of the specific foam stabilizer.

Further, a characteristic of the present invention resides is the small change in hardness (-25°C/23°C hardness ratio). **See also Claim 47.** The claimed hardness ratio is not disclosed by Takeyasu et al (US 5,093,380), and EP-1,022,300 A1.

Therefore, the rejections over Takeyasu et al and EP-1,022,300 A1 and Kiamil et al are believed to be unsustainable as the present invention is neither anticipated nor obvious and withdrawal of these rejections is respectfully requested.

The double patenting rejection over the claims of U.S. 6,734,219 in view of Kiamil et al and Takeyasu et al is traversed. The claims of the parent patent, U.S. 6,734,219, do not render the presently-claimed invention obvious, because one skilled in the art could not have predicted from the patent claims the significance of using the presently-claimed **prepolymer-modified polymethylenepolyphenyl polyisocyanate which comprises reacted units of polyethylene glycol monomethyl ether and polymethylenepolyphenyl polyisocyanate** as the polyisocyanate compound and the superior results obtained thereby. In addition, there is no disclosure or suggestion in the claims of U.S. 6,734,219 in view of Kiamil et al and Takeyasu et al **of the use of a crosslinking agent having a molecular weight from 4000 to 10000 and at least two functional groups** as claimed. Thus, this rejection should be withdrawn.

The rejection of the claims under 35 U.S.C. § 112, 1st paragraph, is obviated by the amendment of Claims 21 and 40.

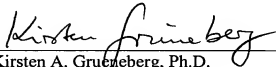
This application presents allowable subject matter, and the Examiner is kindly requested to pass it to issue. Should the Examiner have any questions regarding the claims or

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otherwise wish to discuss this case, he is kindly invited to contact Applicants' below-signed representative, who would be happy to provide any assistance deemed necessary in speeding this application to allowance.

Respectfully submitted,

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